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Psychophysiological Reactivity in Female Sexual Abuse Survivors

Annmarie McDonagh-Coyle,[1,2,6] Gregory J. McHugo,[1,2,3] Matthew J. Friedman,[1,2,4] Paula P. Schnurr,[1,2] Claudia Zayfert,[1,2] and Monica Descamps[1,2,5]

This study examined psychophysiological reactivity in 37 female childhood sexual abuse (CSA) survivors. After assessment of posttraumatic stress disorder (PTSD), psychiatric comorbidity, and trauma history, we conducted a psychophysiological assessment of forehead muscle tension, electrodermal activity, and heart rate during a mental arithmetic task and 4 script-driven imagery tasks (neutral, consensual sex, pleasant, and trauma). PTSD symptom severity correlated positively with psychophysiologic changes and negative emotions during the trauma imagery task. During mental arithmetic, PTSD symptom severity correlated negatively with autonomic changes and positively with negative emotions. These results extend earlier PTSD research showing trauma-specific increased psychophysiological reactivity related to CSA in women with PTSD. They further suggest a negative association between PTSD severity and autonomic reactions to mental arithmetic.

KEY WORDS: posttraumatic stress disorder; childhood sexual abuse; psychophysiology; females.

An association between posttraumatic stress disorder (PTSD) and increased psychophysiological reactivity to combat-related stimuli is well documented in studies of male combat veterans (e.g., Blanchard, Kolb, Taylor, & Wittrock, 1989;

[1]National Center for PTSD, VA Medical and Regional Office Center, White River Junction, Vermont.
[2]Department of Psychiatry, Dartmouth Medical School, Hanover, New Hampshire.
[3]Department of Community and Family Medicine, Dartmouth Medical School, Hanover, New Hampshire.
[4]Department of Pharmacology, Dartmouth Medical School, Hanover, New Hampshire.
[5]Present address: Center for the Study and Treatment of Anxiety, Department of Psychiatry, University of Pennsylvania, Philadelphia, Pennsylvania.
[6]To whom correspondence should be addressed at the National Center for PTSD (116D), VA Medical and Regional Office Center, White River Junction, Vermont 05009; e-mail: mcdonagh_coyle@dartmouth.edu.

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Keane et al., 1998; Orr, Pitman, Lasko, & Lawrence, 1993; Pitman et al., 1990), motor vehicle accident survivors (e.g., Blanchard, Hickling, Taylor, Loos, & Gerardi, 1994), and in mixed trauma samples (Shalev, Orr, & Pitman, 1993). There are also data about such reactivity among women who have PTSD due to childhood sexual abuse (PTSD–CSA). In a recent study, Orr, Lasko, et al. (1998) compared women with histories of CSA who had full PTSD, partial PTSD, and no PTSD. All three groups reacted to the trauma-related stimuli, but women with full PTSD showed significantly greater increases in heart rate (HR) and forehead muscle tension than did women without PTSD. In a related study, this group found that the CSA-exposed women with current PTSD or lifetime PTSD had greater HR responses and slower habituation of skin conductance responses to auditory startle stimuli compared to the CSA-exposed women without PTSD (Metzger et al., 1999). These results suggest that women with PTSD–CSA exhibit patterns of psychophysiological responding similar to those observed in male combat veterans with PTSD when confronted either with reminders of their childhood trauma or with startling tones.

The purpose of this study was to replicate earlier psychophysiological research through further investigation of women with CSA histories. Primary interest was in comparing psychophysiological reactions across several script-driven imagery tasks, and in examining the specificity of the hyperreactivity to trauma-related cues, as seen in other PTSD subpopulations. In addition, in order to understand how task demands influence subjective and psychophysiological reactions, this study included an active task (i.e., a task requiring participants to choose an answer while being observed), mental arithmetic, that allowed comparison with the passive tasks (i.e., tasks requiring the focus and attention of the participants, but lacking a demand to provide answers), the imagery tasks.

Although an approximately one-third false negative rate for psychophysiological assessment (with standardized interview as the gold standard) makes psychophysiological testing too insensitive a test to stand on its own as a diagnostic tool for PTSD (e.g., Blanchard et al., 1996; Keane et al., 1998; Pitman et al., 1990), there are several other reasons to understand more about the psychophysiology of PTSD in women who are survivors of CSA. Identifying subtypes of PTSD distinguishable by the degree of physiological reactivity to trauma reminders (Keane et al., 1998) could increase our understanding of PTSD. Psychophysiological assessments are useful for assessing treatment interventions (e.g., Boudewyns & Hyer, 1990; Shalev, Orr, & Pitman, 1992). They can also provide prognostic information (e.g., Blanchard et al., 1996; Shalev et al., 1998).

Method

Participants

Ninety-one female volunteers with histories of CSA were recruited from inpatient and outpatient psychiatric settings, and by newspaper advertisements.

Inpatients were recruited after informing staff about the study in a series of meetings, and outpatients were recruited by sending an informational letter to local mental health providers describing the study, inviting comments, questions, and referrals. In both the outpatient and inpatient settings, the process of identifying potential study participants was nonsystematic. Therefore, many people from these pools who were potential study participants were never considered for the study. Some people in current outpatient treatment self-referred in response to our advertisements. All study investigators who had direct contact with participants were also female. During an initial appointment, an investigator reviewed the informed consent form with participants, answered any questions, obtained consent, and completed an initial screening interview. CSA was defined as any sexual contact (including caressing, fondling, or stimulating the genitalia of a child; having the child stimulate the perpetrator's genitalia; and/or oral, anal, or vaginal sex) occurring with anyone 5 or more years older when participant was under age 16. In screening for the history of CSA, the interviewer said the equivalent of, "For the purposes of our study, we have gotten very specific about our study definition of CSA. Although we are aware that there are other experiences that do not fit our definition that are nevertheless abusive, we are limiting our study to people whose experience of abuse fits with the following definition: any sexual contact between a child age 16 or younger, and someone 5 or more years older than that child. By sexual contact we mean any contact by the older person with the child's genital area or breasts, whether that be with hands, mouth, genitalia, any body part, and we also include the older person having the child stimulate their genitals in any way. Has this happened to you?" If the woman answered yes, more detailed questions followed during the Early Trauma Interview. Women were excluded for the following reasons: (1) use of medications that primarily affect the autonomic nervous system, specifically methylphenidate, antihypertensive medications, including beta-blockers, and clonidine; (2) pregnancy; (3) known cardiovascular disease, as evidenced by a history of angina, arrhythmia, or myocardial infarction; (4) current diagnosis of mania, hypomania, schizophrenia, schizoaffective disorder, schizophreniform disorder, brief reactive psychosis, psychotic disorder NOS (not otherwise specified), or any organic psychiatric disorder; or (5) withdrawal from benzodiazepines, alcohol, heroin, other opioids, or narcotics any time during the 2 weeks prior to time of consideration for entry into the study.

Three of the 91 women recruited dropped from the study before we obtained all screening information. Of the 88 volunteers on whom we obtained full screening information, 15 failed to meet study criteria. Reasons for exclusion were acute suicidality ($n = 1$), drug withdrawal and clonidine use ($n = 1$), clonidine use ($n = 1$), propranolol use ($n = 1$), inability to provide informed consent (had a legal guardian; $n = 1$), bipolar disorder ($n = 1$), psychotic depression ($n = 1$), multiple personality disorder ($n = 1$), no CSA memories ($n = 4$), later denial of original CSA report ($n = 1$), study CSA definition not met (perpetrator was 2 years older; $n = 1$). In addition, early in the study, when we were trying to assemble a group with no PTSD and a group with full PTSD, we excluded one person who had partial PTSD (cf. Schnurr, Friedman, & Rosenberg, 1993), and who, therefore, did not fit into either of those categories cleanly. We decided shortly thereafter to take people with partial PTSD. Twenty-seven women who were eligible for the study refused consent. A total of 46 women enrolled in the study and completed the assessment. The first 8 women who completed the assessment were pilot participants with whom we refined study procedures; they are not included in the final study group. Following the pilot phase, 38 women completed the psychophysiological assessment. One participant's laboratory data were lost because of computer error; thus 37 women comprised the final study group.

Measures

Early Trauma Interview (*ETI*; as described in Bremner et al., 1995). We documented a history of sexual abuse, using the ETI, a clinician-administered interview combining open-ended and inventory formats, which assesses history of abusive and nonabusive trauma during childhood. The section addressing sexual experiences includes an open-ended inquiry composed of one broad prompt, followed by 15 closed, behaviorally specific questions. Additional contextual information gathered as part of this measure included relationship to perpetrator, age during the event, frequency of incidents (ranging from less than once a year to more than once a day), and self-reported past and present impact of events on functioning. Information gathered about sexual abuse from this instrument was used to construct the personalized scripts that served as trauma-related stimuli during the laboratory assessment.

Clinician Administered PTSD Scale for DSM-III-R (CAPS-1; Blake et al., 1995). This scale provides a standardized method for making current and lifetime *DSM-III-R* diagnosis of PTSD. The scale measures the intensity and frequency of individual PTSD symptoms in each cluster: reexperiencing, avoidance, and hyperarousal. Frequency ratings range from 0 (*never*) to 4 (*daily or almost every day*), and intensity ratings range from 0 (*none*) to 4 (*extreme distress*). Total scores range from 0 to 136. Studies involving combat veterans have evaluated the psychometric properties of the CAPS (Weathers et al., 1992a, 1992b; Weathers, Blake, & Litz, 1991). The results include test-retest reliability ranging from .90 to .98 for all 17 items, internal consistency (alpha coefficient) of .94 for the severity score (frequency + intensity). Compared to the SCID PTSD module, the CAPS-1 severity score of 65 had a sensitivity of .84 and specificity of .95, and a kappa coefficient of .78. CAPS-1 total severity score correlated at .91 with the Mississippi Scale for Combat-related PTSD (Keane, Caddell, & Taylor, 1988), and at .77 with the PK scale of the MMPI (Keane, Malloy, & Fairbank, 1984) demonstrating good convergent validity.

The index trauma for assessment of PTSD was CSA experience. However, if a participant answered negatively to a question in reference to any of her CSA experiences, she was asked if she had the symptom at all, in relation to any trauma. Thus PTSD symptoms were not exclusively related to CSA in those women who had experienced multiple traumas.

Structured Clinical Interview for DSM-III-R (SCID; Spitzer, Williams, Gibbon, & First, 1989). Information from this standardized interview was used to confirm the screening interview information about Axis I disorders, which were exclusion criteria, and to provide a measure of global functioning (GAF). We administered all Axis I modules of the standard SCID with the exception of the PTSD module. The CAPS replaced the PTSD module of the SCID. Interviewers followed standard instructions for omitting modules when appropriate.

Dissociative Experiences Scale (DES; Carlson & Putnam, 1986). The DES assesses the presence of dissociative symptomatology. The scale consists of a series of 28 questions asking patients to endorse the percentage of the time that they experience the dissociative behavior described. The score is a mean of the percentages endorsed for each item. It has demonstrated good test-retest reliability of .84 after 4–8 weeks, .96 after 4 weeks, good internal reliability of .83 to .93 (split-half) and .95 (Cronbach's alpha), and interrater reliability of .99 across scorers ($n = 20$). In addition, there are data demonstrating convergent and discriminant validity for the instrument (Carlson & Putnam, 1993).

Civilian Mississippi (Vreven, Gudanowski, King, & King, 1995). This 39-item scale provided a self-report of PTSD symptoms. Each item is scored on a 5-point Likert scale, and scores range from 39 to 195. The internal consistency (Cronbach's alpha) in a large group of nonveteran civilians was .86, and item-total correlations were lower than in the combat version (Keane et al., 1988).

State-Trait Anxiety Inventory (STAI; Spielberger, Gorusch, Lushene, Vagg, & Jacobs, 1983). This is a brief self-rating containing 40 items, 20 for state anxiety and 20 for trait anxiety. A 4-point rating scale is used to measure anxiety symptoms; thus, scores range from 20 to 80 on each subscale. Spielberger et al. (1983) reported a test-retest reliability coefficient of .73 for trait anxiety, of .33 for state anxiety and good convergent validity. Internal consistency ranged from .83 to .92.

Procedure

All study procedures and forms were approved by a university committee for the protection of human subjects. Female investigators trained for administration of the structured interviews (CAPS, SCID, and ETI) by using videotapes and training materials provided by the developers and by conducting supervized interviews with pilot participants. Two of the investigators were psychiatrists and two were clinical psychologists (one with an MA in the process of completing her doctoral work and one with a PhD). Interviews were recorded and if the interviewer had questions about an interview, she used the tape to consult with one of the other interviewers and they reached consensus on the rating(s) in question. All four had extensive clinical experience working with trauma survivors. Participants completed the self-report questionnaires (DES, Civilian Mississippi, and STAI) between interview appointments; scoring was according to developer's criteria. The time from the initial informed consent discussion to completion of all phases of study participation ranged from 2 to 39 days ($M = 10.6$, $SD = 8.1$). The SCID and ETI were always completed prior to the psychophysiology laboratory assessment. The CAPS and questionnaire completion usually preceded the laboratory assessment, but occasionally followed it if scheduling necessitated that.

Script preparation. Each participant was exposed to four script-driven imagery tasks during the psychophysiological assessment. Two scripts were created from the participant's experiences (trauma and pleasant), and two were the same for all participants (neutral and consensual sex). Preparation of individualized scripts followed methods developed by Pitman and associates (Pitman et al., 1990; Pitman, Orr, Forgue, de Jong, & Claiborn 1987), which were based on earlier research by Lang (Lang, Levin, Miller, & Kozak, 1983). An interviewer, who was blind to CAPS ratings, asked participants to identify which of the sexually abusive events described during the ETI was most stressful and then to describe the identified event in detail, including any accompanying physiological and emotional responses. The interviewer used this information to compose a 30-s script that portrayed the experience in the second person, present tense. A similar procedure was used to compose a script based on a pleasant experience from the participant's life. The neutral script described a walk through an outdoor garden, and the consensual sex script described an intimate sexual encounter, referring always to the partner as "your lover" thereby avoiding use of gender-specific pronouns. All scripts were 30-s long and were recorded on audiotape in a female voice.

Psychophysiological measures. Data from three channels were collected and stored on an Everex 286 computer through a J&J I-330 interface (Poulsbo, WA). Integrated (i.e., rectified and averaged) electromyographic (EMG) activity was recorded from the forehead (left lateral frontalis muscle), using a standard bipolar placement, with a ground electrode placed in the center of the forehead, just below the hairline. EMG signal amplification was approximately 2,000 times, and the integration time constant was 50 ms, which was not adjustable. Skin conductance level (SCL) was recorded through a bipolar electrode placement from the volar surface of the medial phalanx of the first and third fingers of the nondominant hand. HR was determined using a finger photoplethysmograph to detect each pulse, and a cardiotachometer was used to convert the beat-by-beat data into a rate signal. The sensor was placed on the volar surface of the distal phalanx of the second finger of the nondominant hand. The USE data acquisition system (J&J, Poulsbo, WA) digitized and stored raw data, which were sampled at 8 Hz and averaged over 2-s intervals; thus there were 30 readings per minute per channel.

Laboratory session procedure. The psychophysiological assessment occurred usually within a week of completing the interview process, but in a few cases the CAPS interview followed the psychophysiology session, either later in the same day or on a different day. Participants were seated in a quiet room that included a reclining chair, an intercom, two speakers, and a video camera. An adjoining room contained all recording devices and computer equipment. After wiping the skin with alcohol and then rubbing it with a disposable abrasive pad, disposable EMG electrodes were placed over the prepared sites. Skin conductance sensors were placed on the palmar surface of the medial phalanges of the first and third fingers of the nondominant hand, after cleaning with a quick wipe of distilled water. Finally, the photoplethysmograph was placed on the middle finger of the nondominant hand.

After placing, checking, and making any necessary adjustments to the electrodes, the investigator gave initial instructions and then returned to the control room. Following a 10-min adaptation period, the experimenter played additional taped instructions, pausing to check for comprehension. She provided any necessary corrections and answered questions about the instructions. One practice neutral-imagery trial and a final short summary of the instructions preceded the actual presentation of five tasks.

Forehead EMG, SCL, and HR were recorded before, during, and after the five tasks (four imagery and one mental arithmetic). The order of presentation of the five tasks was randomized over participants. Data were collected during four sequential 30-s epochs: baseline, listen, imagery, and recovery. Participants were instructed to sit quietly with their eyes closed during the baseline and recovery epochs. For the imagery tasks, they were asked to listen carefully during the presentation of the script, imagining the scene as vividly as possible (listen period), and then to continue imagining the scene for an additional 30 s after the presentation stopped (imagery period). For the mental arithmetic task, participants received instructions to count backwards out loud by 7 s beginning from a three-digit number for 1 min (comparable to the listen and imagery epochs).

Following the recovery period of each task, participants used 9-point Likert-type scales to report the intensity with which they felt several discrete emotions during the task. The emotions were described by the following triads: sad, downhearted, blue; angry, irritated, mad; happy, joyful, merry; fearful, scared, threatened; anxious, tense, nervous; disgusted, sickened, repulsed; excited, stimulated, turned-on; numb, disconnected, spacey; ashamed, humiliated, guilty; and powerless, out-of-control, dominated (McHugo, Lanzetta, & Bush, 1991). In addition, participants reported imagery vividness following each imagery task, using a 9-point scale from *not at all vivid* to *extremely vivid.* After the participant completed the ratings, the investigator waited at least 2 min before starting the next task, delaying longer if the participant needed more time to stabilize to the EMG and SC levels she had prior to the first nonpractice task. However, if the participant was not reaching those levels, we waited until four consecutive 30-s recordings were not showing further decreases in those measures. Following the completion of all tasks, the investigator detached the sensors and conducted a debriefing.

Participants also provided two 24-h urine samples and one blood sample before the psychophysiological assessment. Several neurobiological measures were obtained from these samples; these results will be presented separately. Each outpatient and nonpatient participant was paid $40 for participation in the study; inpatients were not paid.

Results

Characteristics of the Study Group

Table 1 shows the characteristics of the final study group. The participants were recruited evenly from inpatient, outpatient, and nonpatient settings. On average, they were middle-aged, had more than a high school education, were working, and were married. The range of scores on the self-report scales (Civilian Mississippi DES, STAI) and on the GAF reflect this diagnostic mix in the study group. Scores on these scales correlated highly with the CAPS total score: Civilian Mississippi, $r(35) = .88, p < .001$; DES, $r(36) = .70, p < .001$; STAI, $r(35) = .68, p < .001$; GAF, $r(36) = -.75, p < .001$.

The original intent of this study was to recruit women who had been victims of CSA and then to compare those with current PTSD to those without it. As shown in Table 1, the women without current PTSD fell into two categories: those who had PTSD in the past only ($n = 8$) and those who had never had PTSD ($n = 4$). The small numbers of women in these two categories precluded examining them as separate groups. In addition, based on results showing that these two groups may differ in their psychophysiological reactions to trauma reminders (Keane et al., 1998; Orr, Lasko, et al., 1998), it did not seem appropriate to combine them into a no-PTSD group. Therefore, the analysis plan for this study was altered from a group-based approach to a correlational one. Rather than treat PTSD in diagnostic categories, PTSD symptom severity (CAPS total score) was used as the primary independent variable. Principal interest was in the association of the CAPS score with psychophysiological reactions during the laboratory tasks. Before reporting the correlational results, we present the responses of the entire study group to the tasks.

Self-Reported Emotional Reactions Following the Tasks

Based on principal components analyses (with Varimax rotation), the 10 emotion-rating items were reduced to 5. Six of the emotion triads (anger, anxious, ashamed, disgusted, fearful, and powerless) covaried strongly, (coefficient

Table 1. Characteristics of the Study Group ($N = 37$)

Recruitment source (%)	
Inpatient	35.0
Outpatient	32.5
Nonpatient	32.5
Age (years)	
M (*SD*)	37.9 (10.8)
Range	18–62
Education level (%)	
Less than high school	5.4
Completed high school	10.8
More than high school	83.8
Marital status (%)	
Never married	24.3
Married or living as married	48.7
Separated or divorced	27.0
Employment status (% employed)	78.3
PTSD diagnosis by Clinician Administered PTSD Scale (%)	
Current	62.2
Lifetime[a]	88.6
PTSD symptom severity by Clinician Administered PTSD Scale	
M (*SD*)	57.8 (32.6)
Range	2–114
Global Assessment Scale	
M (*SD*)	61.3 (19.1)
Range	10–90
Civilian Mississippi Scale	
M (*SD*)[b]	103.4 (26.0)
Range	48–155
Dissociative Experiences Scale	
M (*SD*)[b]	17.5 (15.4)
Range	0.83–54.8
Spielberger Trait Anxiety Inventory	
M (*SD*)[b]	45.8 (14.9)
Range	20–70

[a]Lifetime diagnosis was not available for 2 participants.
[b]Two participants did not complete the paper-and-pencil assessment battery; thus, $N = 35$ for these three scales.

alpha = .94) and thus were averaged to form an overall negative emotion scale. The remaining four single items (excited, happy, numb, and sad) contained unique information and were retained in original form.

Using the self-reported emotion data for the five tasks, a MANOVA approach to repeated measures, not the classical repeated measures ANOVA approach (SPSS MANOVA procedure), was used ($n = 33$, following list-wise deletion). The analysis of the emotion ratings is multivariate in two ways: one way has to do with the inclusion of multiple dependent measures (several self-report rating scales), and the other way has to do with the inclusion of a repeated measure (within-subjects factor; task). There was a highly significant task effect, $F(20, 13) = 18.96$, $p < .001$, and univariate tests indicated significant differences among the five tasks on each rating scale. The neutral and pleasant imagery tasks were rated high on the happy scale and very low on the other four scales. Participants reported moderate levels of happiness and excitement following the consensual sex imagery task, with low levels of numbing, sadness, and negativity. In contrast, participants reported no happiness or excitement, moderate levels of numbing and sadness, and high levels of negative emotion following the CSA imagery task. The mental arithmetic task produced moderate ratings of numbing and negative emotion and very low ratings on the other three scales.

The four script-driven imagery tasks also differed in reported vividness, $F(3, 26) = 12.11$, $p < .001$. For the 29 participants with complete vividness data, the consensual sex imagery was rated as the least vivid, $M = 6.4$, the sexual trauma imagery was rated as the most vivid, $M = 8.4$, and the neutral, $M = 7.3$, and pleasant, $M = 7.9$, imagery were intermediate.

Psychophysiological Reactions During the Five Tasks

Psychophysiological reactions were evaluated as changes in mean level across the four 30-s epochs of each task. Means were computed by averaging the 15 data points per epoch. A two-way (task and epoch) repeated measures MANOVA revealed a significant task-by-epoch interaction for each measure, EMG: $n = 35$, $F(12, 23) = 5.16$, $p < .001$; HR: $n = 36$, $F(12, 24) = 6.88$, $p < .001$; SCL: $n = 36$, $F(12, 24) = 3.79$, $p < .01$.

Four main findings emerge from these analyses. First, because the order of the tasks was randomized across participants, and because ample time was allowed between tasks for psychophysiological stabilization, there were no significant differences on any measure among the five tasks during the baseline period.

The second and most important task effect was that the childhood sexual trauma imagery task produced substantial changes from baseline on each measure during each of the subsequent task epochs. All nine paired t tests (three measures and three epochs) were significant, $ps < .05$, for the trauma imagery task, indicating increased arousal while listening to the script and imagining the situation, which then carried over into the postimagery recovery period.

Third, the mental arithmetic task also produced substantial changes from baseline on each measure during each of the subsequent task epochs. Significant elevations in mean HR and SCL, $ps < .05$, were seen during the task and immediately afterwards, whereas a significant change from baseline for mean forehead EMG was found only during the second half of the task period. (Recall that the second and third 30-s epochs of the mental arithmetic task do not involve listening and imagining, but instead refer to consecutive epochs of serial subtraction with verbal response).

Finally, only three statistically significant changes over time were found within the neutral, personalized pleasant, and consensual sex imagery tasks, and all were for mean SCL. Mean SCL rose significantly from baseline while participants were listening to the consensual sex imagery script, $t(35) = -2.48, p < .05$, and mean SCL declined steadily across the epochs of the neutral imagery task, becoming a statistically significant change from baseline during the imagery period, $t(36) = 4.13, p < .001$, and recovery period, $t(36) = 4.9, p < .001$. These changes were not relevant to our hypotheses, although they do provide a manipulation check on the tasks.

Correlational Analyses

We first report the relationship between PTSD severity and tonic levels of psychophysiological activity, and we then examine the within-task correlations. For the latter analyses, we only included the trauma imagery and mental arithmetic tasks, because the neutral, pleasant, and consensual sex imagery tasks did not produce meaningful psychophysiological differences, and they did not yield distributions of change (phasic) scores with sufficient variability for meaningful correlational analysis.

We examined the association between PTSD severity and resting (tonic) levels of psychophysiological activity by correlating the CAPS total score with the mean EMG, HR, and SCL levels during the adaptation period and each pretask baseline period. None of these correlations was significant.

Table 2 presents the correlations between PTSD severity, phasic psychophysiological reactions during the imagery period (imagery period–baseline period), and self-reported emotions following the task. The major finding was a significant positive association between CAPS total score and both HR change and reported

Table 2. Within-Task Correlations Among PTSD Severity, Psychophysiological Change Scores, and Self-Reported Emotions

Variable	CAPS	ΔEMG	ΔHR	ΔSCL	Negative affect
Trauma Imagery Task					
ΔEMG	.30				
ΔHR	.36*	.14			
ΔSCL	.07	.39*	.42*		
Negative affect	.41*	.05	.25	.16	
Numbing	.18	−.04	−.22	−.15	.11
Mental Arithmetic Task					
ΔEMG	.30				
ΔHR	−.23	−.03			
ΔSCL	−.39*	.17	.54*		
Negative affect	.45*	.21	−.13	−.22	
Numbing	.37*	−.06	−.41*	−.36*	.50*

Note. $N = 36$–37 for the trauma imagery task and 34–35 for mental arithmetic. CAPS – Clinician-Administered PTSD Scale; EMG – frontalis electromyographic activity; HR – heart rate; SCL – skin conductance level.
$^{*}p < .05$.

negative emotion. Participants with greater PTSD symptom severity showed more HR acceleration while imagining their childhood sexual trauma, and they reported more negative emotion following the task, than did participants with less severe PTSD symptoms. The correlation of .30 between forehead EMG changes and PTSD symptom severity, $p = .08$, indicates a similar trend for EMG. Changes in SCL were correlated with changes in HR and forehead EMG, indicating coupling among the physiological measures, but these changes were not associated with symptom severity or self-reported emotion. In fact, no statistically significant association between psychophysiological reactivity and reported emotions during the trauma imagery task was found.

Table 2 also shows the correlations among PTSD symptom severity, phasic psychophysiological reactions during the task (second 30 s of counting baseline period), and self-reported emotions following the task. CAPS total score was associated positively with reports of negative emotion and numbing during this task, and it was associated negatively with changes in SCL. The intensity of reported numbing was also correlated negatively with changes in HR and SCL. This pattern of results indicates that participants with more severe PTSD symptoms reported more numbing (i.e., feelings of being numb, disconnected, and spacey) and more overall negative affect. They also showed less HR and SCL change during the active-coping stress task, than did participants with less severe PTSD symptoms.

Discussion

In this study of female CSA survivors, psychophysiological reactivity correlated positively with PTSD symptom severity when the imagery task contained trauma reminders. There was very little reactivity to neutral, pleasant, or consensual sexual imagery tasks. This specificity is consistent with results of studies in other PTSD subpopulations (e.g., Blanchard et al., 1989, 1994, 1996; Blanchard, Kolb, Gerardi, Ryan, & Pallmeyer, 1986; Gerardi, Blanchard, & Kolb, 1989; Paige, Reid, Allen, & Newton, 1990; Pallmeyer, Blanchard, & Kolb, 1986; Pitman et al., 1990; Pitman, Orr, Forgue, de Jong, & Claiborn, 1987; Resnick, Kilpatrick, & Lipovsky, 1991). Our results are also consistent with Orr et al. (1998), who found a positive association with PTSD symptom severity and physiologic reactivity measured by EMG and HR in their study group of female CSA survivors. Such trauma-specific reactivity fits with the idea that conditioned emotional responses are central to the development and maintenance of PTSD symptoms (Foa, Steketee, & Rothbaum, 1989; Keane, Zimering, & Caddell, 1985).

The lack of correlation between tonic levels of psychophysiological measures and PTSD severity may be due to the low statistical power of our study. Psychophysiological studies of PTSD that have low power do not show an association between PTSD status and baseline physiological measures, whereas those with higher power do show such an association (Prins, Kaloupek, & Keane, 1995). Furthermore, these authors claim that the small tonic effects seen in psychophysiological studies may be due to anticipatory anxiety rather than chronic elevations. Such an explanation is also consistent with Murburg and colleagues' (Murburg, McFall, Lewis, & Veith, 1995) finding that tonic plasma norepinephrine levels are not elevated at baseline in PTSD participants (although they show marked increases when exposed to traumatic stimuli).

In contrast to the positive correlation between HR changes and PTSD symptom severity during the trauma imagery task, women with more severe PTSD symptoms showed less physiological reactivity to the active task, mental arithmetic. This is consistent with the findings of the VA Cooperative Study (Keane et al., 1998), where HR and blood pressure increased less in combat veterans with current PTSD compared to those with past only or no PTSD. Similarly, Blanchard et al. (1989) found less increase in HR response to mental arithmetic for participants with PTSD compared to those without PTSD. Other studies showed a similar, although not statistically significant, pattern (Blanchard et al., 1986; Pallmeyer et al., 1986). Thus far, a compelling explanation for this pattern has not been offered. Nevertheless, the different direction of association between PTSD symptom severity and autonomic reactions across the imagery (a passive task) and mental arithmetic (an active task) tasks suggests that either task content (e.g., trauma-related vs. non-trauma-related), task type (e.g., active vs. passive), or both may be important determinants of psychophysiological and subjective reactions.

Work on the relationship between task appraisals and psychophysiological reactions may provide some reasonable avenues for further exploration of negative correlations between physiological reactivity during mental arithmetic and PTSD symptom severity (e.g., Blascovich, Kibler, Ernest, Tomaka, & Vargas, 1994; Tomaka et al., 1999; Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997). In these studies, individuals who appraised an active task (usually mental arithmetic) as a threat, showed less cardiovascular reactivity than those who appraised the same task as a challenge. Passive tasks, like mental imagery, do not allow one to tease out the psychophysiological profiles these investigators associate with threat and challenge responses.

There are competing explanations for a negative association between PTSD symptom severity and decreased reactivity during a nontrauma-related stressor that do not draw upon subjective appraisal as a mediating variable. For example, Orr, Meyerhoff, Edwards, and Pitman (1998) found men with combat-related PTSD had reduced diastolic blood pressure responsivity to an orthostatic challenge task. They concluded that this decreased responsivity to a purely physiologic stressor suggested a biological rather than psychological explanation for reduced responsivity to generic stressors (like mental arithmetic) in people with PTSD. An orienting response also can lead to decreased HR (Resnick et al., 1991).

Inadequate attention to the task by people with more severe PTSD symptomatology is another possible explanation for this negative association between PTSD symptom severity and psychophysiological reactivity to mental arithmetic. A lack of engagement in the task, which does not contain trauma-related stimuli, may result in less physiological responsivity to the task. Event-related potential (ERP) studies indicate that people with PTSD, compared to those without, may be decreasing their brain stimulation during a neutral tone discrimination task that does not include trauma-related stimuli (Paige et al., 1990). McFarlane and colleagues suggest that the ERP data are consistent with disturbed concentration during the task (McFarlane, Weber, & Clark, 1993).

The negative relationship between self-reports of numbing and psychophysiological changes during mental arithmetic provides another possible explanation for the negative correlation between mental arithmetic and physiological reactivity. The psychophysiology of numbing would be expected to decrease psychophysiological reactivity. For example, it has been proposed that numbing is endorphin-mediated, and endorphins antagonize cardiovascular reactivity (McCubbin et al., 1998). In our study, self-reported numbing did not correlate with psychophysiological changes during the trauma task, but did correlate negatively during the mental arithmetic task. A possible explanation for this discrepancy could be that self-reported numbing is actually measuring two different psychological states. One such state could be numbing as described in the *DSM-IV* PTSD criteria, which might be endorphin mediated; another is dissociation, which might be an NMDA glutamatergic activity (Krystal, Bennett, Bremner, Southwick, & Charney, 1995). It is also possible that even if the self-reported numbing scale was measuring the same underlying construct during both mental arithmetic and trauma imagery, the increased intensity of negative emotion experienced during the trauma task could have nullified the impact of numbing on psychophysiological reactivity. Recent data suggest that emotional numbing is best predicted by the intensity of self-reported hyperarousal symptoms (Litz et al., 1997). The PTSD literature to date does not provide adequate information about the relationship between dissociation/numbing and psychophysiological reactivity, nor on how this relationship might change depending on the nature of the task and of competing emotional responses.

There are several limitations to this study. The study group is not necessarily representative of the population of female survivors of CSA. Unknown selection factors operated both in determining who came to our attention for screening and in determining which of those who were eligible chose to participate in the study. In addition, because low numbers of no-PTSD participants were recruited, the final study group was small, which resulted in low statistical power. We did not quantify diagnostic reliability across interviewers. Finally, measuring the frontalis muscle for reactivity instead of the corrugator muscle left us with an assessment of general forehead muscle tension rather than a more specific assessment of negative affect, such as that provided by measuring corrugator muscle reactivity.

In summary, our results with female survivors of CSA are consistent with the findings in other PTSD subpopulations, that heightened psychophysiological reactivity is associated with reminders of the trauma and with PTSD symptom severity. In addition, our finding of a negative association between PTSD symptom severity and psychophysiological reactivity for the mental arithmetic task is consistent with other studies of PTSD. Together, these results point to the need to examine how appraisal processes and other individual differences mediate psychophysiological responses to laboratory stress tasks.

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